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Primary School Achievement in English and Mathematics in Zimbabwe

A Multi-Level Analysis

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and
Abby Riddell

In Zimbabwe's primary schools, higher achievement in math is associated with the amount of teacher training and instructional time, as well as the pupil-teacher ratio. Higher achievement in English is associated with the pupil-teacher and textbook-to-pupil ratios as well as the amount of teacher training.

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This paper — a product of the Education and Social Policy Department — was prepared for the *Building Research Capacity* work program, which helps countries improve their capabilities in education research, evaluation, and assessments so they can inform policymakers about local learning conditions. Support for the research was provided by the Population and Human Resources Department and the African Capacity Development Fund. Copies of this paper are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Ian Conachy, room S6-228, extension 33669 (October 1993, 33 pages).

Using a multilevel modeling procedure, Nyagura and Riddell explore:

- The percentage of variance in primary school achievement in Zimbabwe that could be attributed to the types of schools and classes attended.

- The differences between schools in student achievement in mathematics and English.

- The reasons for these differences.

They compare five types of schools. Students in Former A ("European") schools and high-fee schools outperform those in Former B ("African") schools, low-fee schools, and district council schools in both subjects.

In English, school-type differences persist after controlling for student intake variables. For mathematics, they disappear.

School and class variables related to higher math achievement include the amount of teacher training and instructional time, and pupil-teacher ratio.

Higher achievement in English is related to the pupil-teacher and textbook-to-pupil ratios, and to the amount of teacher training.

Education and Social Policy Department
Human Resources Development and Operations Policy
The World Bank

Primary School Achievement in English and Mathematics in Zimbabwe: A Multilevel Analysis

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* The helpful comments of Rosemary Bellew and Marlaine E. Lockheed are gratefully acknowledged.

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- Larach and Lockheed (1992) *World Bank Lending for Educational Testing: A General Operational Review.* PHREE/92/62R;

- Lockheed (1991) *Multidimensional Evaluation: Measures for both right hand and left hand sides of the equation.* PHREE/91/46;

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Primary School Achievement in English and Mathematics in Zimbabwe: A Multilevel Analysis

I. Introduction

1. Zimbabwe has undergone tremendous expansion in its education system since Independence in 1980. Primary school enrollment doubled in the first three years of Independence and has grown steadily ever since. Access to primary education is now almost universal. Like secondary education, which has undergone even more rapid expansion, the initial concern with access has given way to an increased focus on the quality of education. Alongside the rapid expansion in the numbers of schools and students enrolled at primary and secondary education has been a correspondent rapid increase in the numbers enrolled in teachers' colleges—an increase of nearly five-fold in the first ten years of Independence. To the extent that examination scores on mathematics and English achievement tests are a measure of school quality, this study aims to identify what factors account for differences in school quality across the range of Zimbabwean schools.

The Education System

2. Zimbabwe inherited a set of highly disparate educational institutions, which reflected the racially discriminating policies of the white settler community as well as a British colonial pattern of education, designed to offer different types of education for different economic classes. Since Independence, new schooltypes have been added, overwhelming relying on local communities to establish schools under the authority of the district councils in the rural areas, or the city councils in the new high-density urban areas. In addition, the number of private, high-fee-paying schools has increased since Independence, swelling the ranks of schools alternative to the central government- and mission-run schools formerly catering to the so-called 'Europeans' (whites), or increasingly, the relatively well-off of all races. The gamut of schooltypes explored in this study, therefore, goes from the prototypical, well-endowed, English 'public' school to the newer and relatively under-resourced district and city council schools.

3. Zimbabwe's education system has a seven year primary cycle followed by a four year plus two year secondary cycle. Whereas the examinations in mathematics and English given at Grade 7 used to be for the purpose of selecting those able to advance to secondary school, they are no longer intended for such purpose, though in practice, they are often used as a streaming device for secondary school classes as well as a weeding device between secondary schools. The transition rate to secondary school from Grade 7 at Independence was 27%, but this rate shot up to 86% in the first year of Independence, as those formerly denied a secondary education were afforded access to the new schools. By 1990 these high rates had dropped to about two-thirds of Grade 7 completers entering Form I classes.[1]

4. Three questions comprise the focal points of this study of Zimbabwe's primary schools ten years after Independence:

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[1] Form I is equivalent to Grade 8. No study has been carried out to determine the factors behind the differential rates of access—no less attainment—at secondary school since Independence, but it can be assumed that a combination of factors is responsible, including the adjustment of the system to over-age students, initially, the establishment of new secondary schools, and two additional factors which require investigation: changes in the quality of education and the elasticity of demand for secondary education given different household characteristics.

(a) What differences across schooltypes can be found in English and mathematic achievements at Grade 7, the final year of primary schooling?
(b) What accounts for between-school variation in English and mathematic achievements?
(c) Which are the most 'effective' primary schools in Zimbabwe?

Schooltypes

5. Education policy since Independence has changed the nature of many of the schooltypes inherited in 1980. Not the least of such policies has been the abolition of racial discrimination. For instance, the former whites-only central-government-run schools are now predominantly black. Such changes, however, have not completely altered their inherited traditions. On the surface, the uniforms have often remained the same so that if the streets of Salisbury were once filled with little Gatsby-esque 'Englishmen' in their boater hats, similar apparel now adorns African faces in Harare. The surface traditions, however, belie the schooltype differences which we wish to investigate here, some of which relate to pre-existing, physical resource endowments as well as ethos.[2]

6. Five schooltypes were selected as representative of the gamut of schooltypes existing in the country in 1990. Two central government schooltypes, the former 'Group A' and the former 'Group B' schools were included. These schools are funded predominantly by the government.[3] Group A schools were those catering for the so-called 'European' community prior to Independence and had well-trained teachers, well-resourced physical plants and active parent-teacher associations. Group B schools were those catering to the African urban population and had less favorable resources afforded them both by government as well as by the less-well-off parents whose children they served. Staffing of Group B schools reflected the non-standard (less arduous) teachers' qualifications permitted in these schools. Different pupil-teacher ratios were legislated before Independence for the different government schools. Today, although they have been equalized, the physical plant of the Group A schools, catering for smaller class sizes, has made it difficult to equalize resources across them in practice.

7. Distinct from central-government-funded schools are three alternative schooltypes: 'high-fee-paying schools' and two forms of local-government-funded schools, 'low-fee-paying' and 'district council' schools. 'High-fee-paying schools' are what they say they are, but in addition, comprise really two strands of 'private' schooltypes. They include the mission schools, often boarding, which have a long history in Zimbabwe, dating back to the turn of the century and catering for both 'European' and African communities, traditionally separately. In addition are the schools based on the English 'public school' prototype, being well-endowed in every respect, and designed for the well-to-do. Some of these have been around for many years, but added to their number are many more which have been registered since

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[2] Although data were not collected in this study on variables related to school 'ethos', it is assumed that in delineating the different schooltypes and stratifying the sample according to these schooltypes that some of the differentiation unaccounted for by the physical resource variables on which data were collected can be traced to such harder-to-research factors—and indeed should be the subject of further investigations of the 'effective' schools identified. Had government schools been taken together as one schooltype, this differentiation evidenced in this research would have been lost

[3] Tuition was not charged at primary schools in Zimbabwe until 1992 when differential rates were introduced for rural vs. urban schools in an attempt to have parents who were able to pay, especially in the urban areas, contribute to the costs of their children's education on a scale similar to the sacrifices made by parents in the rural areas in the establishment, no less endowment, of their new schools.

Independence, and which are designed to cater to a similar clientele, enlarged by those numbers retreating from what is no longer an exclusive government system.[4]

8. The remaining two schooltype classifications both derive from local government sources, and are new since Independence, the 'low-fee-paying schools' catering to the African urban population not served by the insufficient numbers of central government schools, and the district council schools, serving similarly under-provided, rural African communities. Both local government schooltypes share poor resource bases due to their recent establishment, as well as the relative poverty of the communities from which they obtain their support.

9. All five schooltypes delineated in this study receive central government funding for their operation, namely in teachers' salaries, afforded on the basis of the same pupil-teacher ratio throughout, and the same per capita grants across the non-central government schooltypes. The central government schooltypes have all of their major running costs paid for by the central government, unlike the rest which have to make up the difference from parents' pockets or other sources (e.g., beer hall profits).

II. Data and Method

Sample

10. The target group for this study consisted of 1990 Grade 7 pupils, their teachers and the heads of their schools. The school population was stratified into the five schooltypes described above. Three regions were selected from which schools were randomly sampled from randomly selected districts. Criteria for selecting the regions were that a fair representation of Ndebele and Shona children should be included, as well as a fair representation of both urban and rural schools.

11. The districts and the number of schools selected were:

(a) In Harare Region: Harare District (31 schools).
(b) In Mashonaland West Region: Chegutu (7 schools), Kadoma (9 schools), Lomagundi (9 schools), Hurungwe (10 schools), and Kariba (3 schools).
(c) In Matabeleland North Region: Bulawayo (14 schools), Binga (4 schools), Bubi (4 schools), Hwange (5 schools), Lupane (7 schools), Nkayi (7 schools) and Nyamandlovu (8 schools).

12. A stratified random sample proportional to the size of the primary schools and the size of the districts in the chosen regions was drawn. All Grade 7 children and their teachers at the selected schools were then surveyed, as well as the heads of all the schools. Table 1 provides a breakdown of the sample by schooltype, classes and pupils.[5]

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[4] It is not necessary to suggest that the motives of this enlarged clientele are racist. The enlarged numbers are seeking out more exclusive, and in their view, higher-quality schools, at minimum, on grounds of class, if not for other reasons.

[5] It would not appear that the numbers of schools sampled within each of the schooltype strata reflect the representation of that schooltype within the total population of schools. Statistics for 1991 show that some 6% of primary schools in Zimbabwe were government schools, 6% (mission and trust schools, read 'high-fee-paying'), 1% urban council (read 'low-fee-paying'), 73% district council schools, 5% rural council schools and 9% other types of schools. (Ross and Postlethwaite 1992, p.4) Government and low-fee-paying schools seem to be oversampled, which would give an urban bias to the sample.

Table 1. Breakdown of Sample by School Type, Classes and Pupils
(percent)

	Original School Sample			Final Sample					
				School		Class		Pupils	
School Type	*N*	%[b]	*Response Rate (%[b])*	*N*	%[c]	*N*	%[c]	*N*	%[c]
Former A	14	12	64	9	10[c]	19	10[c]	642	9[c]
Former B	19	16	53	10	12	44	23	1840	27
High Fee Paying	9	8	78	7	8	14	7	408	6
Low Fee Paying	15	13	73	11	13	34	18	1380	20
District Council	61	52	80	49	57	81	42	2657	38
Total	118	100	73	86	100	192	100	6927	100

Notes:
[a] A = Former Government Group A; B = Former Government Group B;
HFP = High Fee-Paying; LFP = Low Fee-Paying; DC = District Council
[b] Percentage of original sample
[c] Percentage of final sample

Variables

13. The variables on which information was collected were at three levels, describing differences between students in their backgrounds, between classes, and between schools. Three questionnaires were used to collect this information, addressed to the students, their Grade 7 teachers, and the heads of their schools. In addition, other information was collected from the Ministry of Education's statistical returns, the ED46 (Part II). Data for the study were collected between July and December 1990.

14. The *outcome variables* used were Grade 7 Examination scores in English and mathematics, obtained from the Examinations Branch of the Ministry of Education. These exams are scored on a stanine scale, from 9 (low) to 1 (high). In order for the results of the regressions to be more easily interpretable, these scores were transformed (new score=10-old score) so that 9, instead of 1, is the highest score. The *student variables* include gender, age, years spent in pre-school, years taken to complete primary education, days the pupil was absent from school, time devoted to English and mathematics homework, home language, number of children in the family and parents' education levels.

15. *Class level variables* report teachers' information (gender, age, qualification, experience), teacher's use of time for academic activities and games and sports, class size, class textbook availability in English and mathematics, and teaching load.

16. *School level variables* include organizational information (streaming of pupils, number of sessions, teacher stability, distribution of time to academic and sports activities, school size, time devoted to school-based inservice activities), material and non-material inputs (textbook availability, library books, teacher experience, percentage trained teachers, professional support to teachers through supervision by the head teacher), social composition (ethnic and gender composition of the school, boarding status), and

head teacher's data (gender, qualification, teaching experience, administrative experience, and whether received training as a head teacher.)

17. The complete list of variables on which information was collected can be found in Annex A. The differences between the schooltypes can be easily judged, variable by variable, from Tables 2-4, which reports means and standard deviations (in parentheses) for variables included in this study.[6]

Pupil Level Differences

18. As can be seen in Table 2, the highest average scores in both subjects are obtained at the high-fee-paying and former Group A schools. As already pointed out under the description of variables, scores range from 1 (low) to 9 (high); scores of 4-9 are considered passing. Table 2 also illustrates the differences in intake of the different schooltypes by student background variables, which may account for some of these differences in achievement. Relative to an average of 44% of the fathers of the sampled student population having no education, 66% of the fathers of district council school pupils were uneducated, against lows of 7% and 14%, respectively, for former Group A and high-fee-paying schools. Whereas more than half of the fathers of the pupils sampled in the high-fee-paying and Group A schools had secondary education, only 1 to 2% were similarly educated at the district council, Group B, and low-fee-paying schools. In addition to coming from less educated families, students attending the low-fee-paying and district council schools come from larger families and district council school pupils take longer, on average, to complete primary education.

Class Level Differences

19. Information collected at the class level illustrates significant schooltype differences as well (Table 3). The lowest percentage of female teachers are found in district council schools, 8% on average, whereas 79% of the teachers in the high-fee-paying schools surveyed were women.[7] 77% of the teachers surveyed claimed that they had received 'standard' teacher training requiring completion of Form IV plus

[6] Only those variables capable of being utilized in the study are reported in Table 2. This is not the complete list, because in the data entry, the value 0 used for 'non-response' overlapped with a real value of 0, making these variables unusable. The variables which had to be eliminated from the analysis for this reason included: PRESCHYR (Years spent in pre-school); DAYSABS (Number of days a pupil was absent from school in terms 1 and 2 of 1990); EHWTIME and MHWTIME (hours per week devoted to English or mathematics homework, respectively); TCHABS (Number of days a teacher was absent from school in terms 1 and 2 of 1990); EUNSUP and MUNSUP (Unsupervised English/mathematics study hours per week); and LIBBOOKS (Total number of books in the school library).

[7] On its own, one cannot make much of such a statistic, but further investigation would be appropriate to determine the reasons behind such gender disparities in teacher allocation. It could reflect the inadequacy of teachers' housing and the difficulty of young, unmarried women moving out to rural areas different from their own, particularly as untrained or less experienced, new recruits comprise the majority of those taking up such positions.

Table 2. Mean Values of Student-Level Variables by Schooltype
(standard deviations in parentheses)

Variable	*All Schools*	*Former Group A*	*Former Group B*	*High Fee Paying*	*Low Fee Paying*	*District Council*
Grade 7 English score	5.7	8.2	5.7	8.2	5.7	4.6
	(2.2)	(1.2)	(1.9)	(1.7)	(2.0)	(1.9)
Grade 7 mathematics score	4.9	6.8	4.7	6.8	5.2	4.1
	(2.2)	(1.9)	(2.1)	(2.0)	(2.1)	(2.0)
Age in years	13.7	12.9	13.5	12.7	13.9	14.1
	(1.5)	(0.8)	(1.1)	(1.2)	(1.4)	(1.7)
Years taken to reach Gr. 7	7.2	7.1	7.1	7.2	7.2	7.4
	(0.6)	(0.4)	(0.5)	(0.5)	(0.5)	(0.9)
Number of children in family	6.6	5.8	5.7	5.4	7.1	7.7
	(3.9)	(2.1)	(3.7)	(1.8)	(4.0)	(4.4)
Father's education						
No education	44%	7%	42%	14%	43%	66%
Primary	16%	5%	19%	5%	18%	18%
Junior Certificate	24%	36%	30%	19%	29%	13%
O-Level	10%	25%	9%	28%	8%	2%
A-Level or higher	6%	26%	1%	35%	2%	1%
Mother's education						
No education	52%	12%	50%	11%	54%	75%
Primary	20%	16%	24%	9%	23%	18%
Junior Certificate	19%	45%	23%	23%	19%	6%
O-Level	6%	14%	4%	31%	3%	1%
A-Level or higher	4%	14%	-	26%	1%	-

Note: For categorical variables percentages in each category are shown

3-4 years of teacher training.[8] The highest proportion of untrained teachers was found in the district council schools—25%. Further teacher characteristics underline the discrepancies in teachers'

[8] This statistic seems high and could reflect either inflated reporting on the part of the teachers surveyed or a misunderstanding of the various categories of qualification. About 50% of primary school teachers were untrained in 1990. However, it is possible that within schools, the allocation of trained teachers is more in favor of the Grade 7 classes, thus accounting for this discrepancy. Such an hypothesis would be borne out in part if school level reporting of percentages of trained teachers were closer to the expected figures. As one will see below, the figures at the school lean in this direction, but higher proportions of 'standard trained' teachers are still reported than what would be expected.

backgrounds across the various schooltypes: the youngest—as well as least experienced, understandably—teachers are found in the district council schools. Whereas the average age of teachers at high-fee-paying schools was 42, with 18 years of teaching experience, the average age of teachers at district council schools was 30, with an average of 9 years of teaching experience. As would be expected, less experienced teachers require longer planning time to prepare their classes. Nearly twice as much time is spent in class preparation at district council schools relative to high-fee-paying schools.

20. Average class sizes ranged from 31 at the high-fee-paying schools up to 43 at the low-fee-paying schools. The less well-resourced urban schools have to contend with larger numbers of pupils on top of their other disadvantages. The discrepancy inherited between Group A and other urban schools is still prevalent—their average class size is closer to the high-fee-paying schools than the other central or local government schools. This is no doubt related to the smaller physical classroom sizes, among other factors.

21. If some of the above schooltype differences could have been anticipated, one of the most striking facts uncovered in the descriptive analysis of schooltype differences is that low-fee-paying and district council schools spend only three-quarters of the amount of time in mathematics instruction in comparison with other school types. It could be that fewer hours of instructional time is related to the larger teaching loads of teachers at these schools. An extra 3-5 hours teaching per week is assigned district council school teachers, relative to their counterparts in other schooltypes. Peculiarly, while district council school teachers spend less time on average on mathematics instruction, they spend more time on average in teaching games.

22. Add to the above factors the lower availability of textbooks at the classroom level, and before the more poorly qualified teacher has even entered the classroom, one has weighed in very disparate factors across the various schooltypes. There are three tiers in the availability of textbooks: pupils at district council schools have fewer than one textbook for every two pupils; at low-fee-paying and Group B schools two textbooks are shared, on average, between three pupils; and at Group A and high-fee-paying schools, there is just under one textbook for every pupil on average.

23. Eight other class level variables on which data were collected in all schools were not found to differ significantly across schooltypes.[9] They relate to the amount of time a teacher uses for planning classes in mathematics, marking in both subjects, the overall instructional time in English, and the amount of time given to classroom activities and supervised study in both subjects. As can be seen from examining Table 2, there are larger discrepancies across the English planning time variable than is the case for mathematics. The opposite holds true for the amount of instructional time in mathematics or English.

School Level Differences

24. Differences between schooltypes are also found in comparisons of school-level variables, further highlighting what seems to be the underlying principle: 'to those that have, they shall be given,' rather than the other way around (Table 4). For instance, if it is assumed that it is a more difficult task to create a new school than to carry on the traditions of an older one, it would seem appropriate to allocate the most experienced head teachers to the newer schools, rather than filling the ranks of the older,

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[9] $(p > .05)$

Table 3. Mean Values of Class-Level Variables by School Types
(standard deviations in parentheses)

Variable	*All Schools*	*Former Group A*	*Former Group B*	*High Fee Paying*	*Low Fee Paying*	*District Council*
Female teacher	27%	26%	41%	79%	32%	8%
Teacher's age	33.3	37.2	36.0	42.2	31.3	30.0
	(8.8)	(7.4)	(8.7)	(12.3)	(6.3)	(7.6)
Teacher's qualification						
Standard trained (Form IV and Cert. Ed.)	77%	100%	71%	79%	88%	69%
Form IV and 2 years	3%	-	7%	14%	3%	-
Form II and 2-3 years (PTL/PTH/T3/T4)	10%	-	23%	7%	6%	7%
Untrained	11%	-	-	-	3%	25%
Teacher experience	10.9	13.7	12.5	17.9	8.5	9.1
	(8.6)	(8.0)	(9.5)	(9.5)	(5.5)	(8.4)
Class size	37.8	33.8	42.6	31.1	42.9	35.0
	(7.7)	(6.7)	(3.3)	(4.7)	(3.6)	(8.6)
Hours/week planning	4.7	3.7	4.6	2.9	4.3	5.6
English	(3.4)	(2.5)	(2.3)	(1.6)	(2.4)	(4.3)
Hours/week planning	4.2	3.8	4.3	2.8	3.9	4.7
mathematics[a]	(3.2)	(2.6)	(2.3)	(1.4)	(2.7)	(4.0)
Hours/week grading	5.8	5.0	5.8	5.7	5.5	6.2
English[a]	(3.3)	(2.5)	(3.1)	(3.0)	(2.4)	(3.9)
Hours/week grading	4.9	5.1	4.9	5.3	4.2	5.2
mathematics[a]	(3.1)	(2.8)	(3.3)	(2.2)	(2.2)	(3.4)
Instructional hours in	164	164	171	162	169	159
English[a]	(51)	(65)	(76)	(38)	(44)	(32)
Instructional hours in	103	123	120	126	92	90
mathematics	(51)	(71)	(71)	(38)	(48)	(25)
Hours/week class	3.3	3.7	3.0	2.9	3.5	3.5
activities in English[a]	(1.9)	(2.3)	(1.5)	(1.9)	(1.6)	(2.1)
Hours/week class	2.8	3.2	2.5	2.8	2.5	3.0
activities in mathematics	(1.7)	(2.0)	(1.3)	(1.2)	(1.2)	(2.1)
Grade 7 English textbook	.61	.92	.69	.88	.65	.42
to pupil ratio	(.29)	(.19)	(.28)	(.22)	(.31)	(.19)
Grade 7 mathematics	.63	.95	.63	.92	.68	.48
textbook to pupil ratio	(.30)	(.16)	(.28)	(.22)	(.29)	(.25)
Hours/week supervised	2.9	2.6	3.4	3.9	2.8	2.5
study in English[a]	(2.1)	(2.2)	(2.3)	(1.9)	(2.2)	(1.7)
Hours/week supervised	2.6	3.1	2.7	3.2	2.2	2.4
study in mathematics[a]	(1.8)	(2.3)	(2.2)	(1.3)	(1.3)	(1.8)
Teacher's teaching	26.9	24.2	25.6	25.8	26.4	28.8
hours/week	(6.0)	(1.5)	(4.4)	(6.1)	(6.2)	(7.0)
Teacher's hours/week on	26.9	24.2	25.6	25.8	26.4	28.8
games	(6.0)	(1.5)	(4.4)	(6.1)	(6.2)	(7.0)

Note: [a] Contrasts not significant ($p > .05$).
For categorical variables percentages in each category are shown

established schools. Unfortunately, as we saw in reviewing the proportion of untrained teachers at different schooltypes, it was those in greatest need who attracted the least qualified staff. The least experienced head teachers were in charge of the district council schools. Similarly, as with teachers, the fewest number of female school heads were found at the district council schools, some 2%, compared with a high of 57% in the case of the high-fee-paying schools.

25. Regarding school organization, the norm is for coeducational unstreamed day schools. Single-sex schools were found only among Group A and the high-fee-paying schools. (There are others in the wider population, but this is characteristic.) This was also the case for boarding schools: they were only found at Group A and high-fee-paying schools. Finally most primary schools do not stream their classes by ability levels. However, where this is most prevalent is in the Group A schools, followed by the high-fee-paying schools.[10]

26. The largest schools, understandably, practice double-sessioning. This is in the case of the Group B and low-fee-paying schools, whose average sizes are 1462 and 1023 pupils, respectively, compared to average figures between 432 and 645 for the rest. The lowest pupil-teacher ratios were found at the high-fee-paying schools (25), followed by the Group A schools (33). There is still a good deal of disparity between central government schooltypes. The average pupil-teacher ratio for the Group B schools was 38—closer to the averages for district council and low-fee-paying schools than to Group A schools.

27. Several of the schooltype variables demonstrate the same discrepancies illustrated as those detailed at the class level. For instance, the percentage of 'standard' trained teachers varies from 49% for district council schools to 96% for high-fee-paying schools. It is encouraging that the amount of supervision afforded both experienced and inexperienced teachers at district council schools is considerably higher than at the other schooltypes, averaging three visits per term, as against fewer than two visits per term at the other schooltypes. The least experienced teachers are found at the low-fee-paying schools, set off even from the district council schools, with an average of four versus seven years teaching experience on average. Teacher stability is similarly lowest at the low-fee-paying schools, even with respect to the district council schools, averaging 2.8 vs. 4.5 years, respectively. Textbook provision across the schooltypes varies from a low of one textbook to every three children in the district council schools up to four textbooks for every five children at the high-fee-paying schools.

28. Differences in resource availability between the various types of primary schools in Zimbabwe are pronounced, especially in quantity and types of material and non-material resource. A survey of 30 of the 86 primary schools in this study revealed that of the 12 material inputs listed in Table 5, rural district council schools on average had only 30 percent, while low fee paying schools had 55 percent, former Group B schools had 56 percent, former Group A schools had 80 percent and high fee paying schools had almost all the resources. Rural district council schools are further constrained by shortages of classroom level resources such as chalk, pens and pencils, paper, maps and charts and dictionaries. Deserving of special note are the unexpected significant shortages of basic instructional materials in former group A, former group B and low fee paying primary schools. In particular only 57 percent of former group A government schools reported always having enough of pens and pencils, writing paper/exercise books, maps, charts and dictionaries. As many as 29 percent of former group A

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[10] Of course taking the head teacher's word for granted may not be portraying the real situation. In previous studies in which such questions were asked, the heads' answers did not tally with the descriptive analysis of streaming. It is presumed that this was because streaming is frowned upon by the Ministry of Education, given that the Grade 7 test is not intended as a selection device. See Riddell (1988).

Table 4. Mean Values of School-level Variables by School Type
(standard deviations in parentheses)

Variable	*All Schools*	*Former Group A*	*Former Group B*	*High Fee Paying*	*Low Fee Paying*	*District Council*
Female headmaster	9%	-	10%	57%	18%	2%
Headmaster's teaching	22.0	23.8	26.9	26.6	18.7	20.7
experience in years[a]	(9.5)	(10.1)	(7.1)	(8.9)	(7.1)	(10.1)
Coeducational school	95%	89%	100%	57%	100%	100%
Boarding school	8%	22%	0%	57%	9%	0%
Steaming	33%	67%	10%	43%	27%	31%
Two sessions	41%	0%	90%	14%	55%	39%
Pupil enrollment	645	619	1462	432	1023	429
	(473)	(243)	(265)	(138)	(628)	(251)
Pupil to teacher ratio	36.6	32.9	38.0	25.4	37.5	38.5
	(6.2)	(4.4)	(2.7)	(6.9)	(9.3)	(3.8)
Percent pupils African	92.6	79.0	100.0	36.7	100.0	100.0
	(20.3)	(17.3)	(0)	(28.7)	(0)	(0)
School time in hours[a]	1007	925	1062	1027	1003	1009
	(132)	(65)	(117)	(107)	(161)	(137)
Academic time in hours [a]	699	648	688	659	729	711
	(122)	(118)	(139)	(88)	(153)	(116)
Game time in hours [a]	228	307	210	224	284	205
	(151)	(133)	(136)	(110)	(184)	(151)
Professional time in hours [a]	23.9	18.3	20.9	13.5	19.9	28.0
	(17.0)	(23.6)	(13.2)	(7.0)	(12.7)	(17.7)
Headmaster supervision of	2.4	1.7	1.5	1.5	1.7	3.0
experienced teachers	(1.9)	(.9)	(1.0)	(.5)	(.9)	(2.2)
Headmaster supervision of	2.4	1.7	1.5	1.5	1.7	3.0
inexperienced teachers	(1.9)	(.9)	(1.0)	(.5)	(.9)	(2.2)
Mathematics textbook to pupil	.50	.75	.52	.83	.59	.39
ratio for all grades	(.25)	(.31)	(.18)	(.29)	(.20)	(.17)
English textbook to pupil ratio	.50	.75	.52	.83	.59	.39
for all grades	(.25)	(.31)	(.18)	(.29)	(.20)	(.17)
% Trained teachers	64.8	93.3	87.0	96.4	70.3	49.3
	(28.3)	(7.0)	(7.0)	(7.5)	(24.7)	(24.7)
Average teaching experience in	7.5	7.4	10.4	10.8	42	7.1
years	(4.0)	(1.3)	(2.8)	(6.6)	(1.1)	(3.9)
Average teaching experience in	4.5	4.1	6.9	5.2	2.8	4.5
this school	(2.0)	(1.2)	(1.5)	(1.9)	(1.4)	(1.9)

Notes: [a] Contrasts not significant ($p > .05$).
For categorical variables percentages in each category are shown.

government schools reported not always having enough instructional guides for their teachers. In former group B government schools over 70 percent did not always have enough pens, pencils, and writing paper/exercise books. Only 14 percent of the former group B schools reported always having enough dictionaries while only 43 percent reported always having enough maps and charts. Regarding chalk and instructional guides only 57 percent of former group B schools always had enough of these resources. The situation in low fee paying schools was comparable to that of former group B government schools except that chalk is always enough in low fee paying schools.

29. Four school-level variables were found to be invariant across schooltypes. These concern the amount of time in the school calendar, the amount of time allocated to academic subjects, to games and sports, and to school-based, professional activities such as in-service workshops.

Methodology

30. Studies of school effectiveness have been plagued by methodological controversy, some of which has been resolved by the use of multilevel regression models. In this study, we have chosen to use the three-level software package ML3 (Prosser, Rasbash, Goldstein 1991). The multilevel regression enables us to model complex relationships simultaneously at different units of analysis and hence overcomes the problem of the choice of unit of analysis. Moreover, the inherent nesting of educational systems in which students are nested in classes which, in turn, are nested in schools, which, themselves, are nested in districts or regions, makes the covariances within each level of direct interest. In contrast, ordinary least squares regression analysis assumes away these structures with the effect of: (a) producing less efficient parameter estimates, the greater is the clustering within these different levels, and (b) losing the interesting interrelationships between the different levels.

III. Results: Modeling English and Mathematics Achievement

31. Five steps were taken in modelling English and mathematics achievement. First, the sources of variation in achievement were determined by modelling a constant at each of the three levels: between students, between classes, and between schools. Second, each variable was regressed individually on English and mathematics achievement in order to weed out insignificant variables and to have a base-line coefficient to compare with the estimates in multiple regression. Third, sets of individual variables at each level were tested in combination in order to obtain the best predictors of student, class, and school level variance in achievement. Fourth, the surviving subsets were tested in combination with each other to render the most powerful equation utilizing the more manipulable variables. Fifth, school level residuals were estimated for each school in order to pick out possible outliers meriting further investigation. At each stage of the analysis, listwise deletion of missing variables was applied to those variables used in a particular regression. This enabled us to retain the largest possible data set at each stage.

32. Punctuating the above set of analyses, we ran several others around schooltype and other contextual differences as well as testing for random effects, the results of which will be discussed later in this paper.

Table 5. Frequency of Resource Availability by Type of Primary School (Percent)

Resource	*High Fee Paying N=4*	*Former Group A N=7*	*Former Group B N=7*	*Low Fee Paying N=7*	*Rural District N=5*
School Vehicle	100	100	0	14	0
Telephone	100	100	86	86	20
File Cabinets	100	100	100	86	60
Typewriter	100	100	100	100	60
Television	100	28	0	14	0
Computer	75	28	0	14	0
Radio	100	43	71	57	80
Duplicating Machine	100	86	86	28	0
Equipped Library	100	86	14	43	0
Staff Room	100	86	86	100	40
School Office	100	100	100	100	100
School Hall	75	100	28	14	0
[All Resources]	[96]	[80]	[56]	[55]	[30]
Always Enough:					
Chalk	100	86	57	100	60
Pens, Pencils	100	57	28	57	40
Paper	100	57	28	71	60
Instructional Guide	100	71	57	43	80
Maps, Charts	100	57	43	28	40
Dictionaries	100	57	14	28	20

Variance Components Models for English and Mathematics Achievement

33. The first model partitions the total variance into the variance between students, between classes, and between schools around an overall mean. The results are given in Table 6. The average achievement in English is 5.41. Of the total variance which we seek to explain, 44% is between schools, 8% between classes, and 48% between students. Typically, in ordinary least squares regression, the variance between students is confounded with that between classes and between schools, making it impossible to ascertain whether the resulting equations are really explaining between school differences or rather, merely the differences between students, implying the basis of their selection into those schools, or, indeed, their choice of those schools.

34. The mean achievement in mathematics, 4.7% is lower than for English. In comparison with the variance components model for English, we can see that schools do not vary as much in mathematics

Table 6. Variance Components Models for English and Mathematics Achievement

	English	% of total variance	Mathematics	% of total variance
Fixed Parameters				
Constant (mean achievement)	5.410	-	4.67	-
Standard error	.18		0.15	
Random Parameters				
Between school variance	2.449	44	1.393	26
Standard error	.42		.29	
Between class variance	.435	8	.764	14
Standard error	.07		.12	
Between student variance	2.71	48	3.176	59
Standard error	.05		.05	
Total variance	5.594	100	5.339	100

achievement as they do in English achievement[11]. Twenty-six percent of overall variance in mathematics achievement is between schools. On the other hand, there is more between class variance in achievement in mathematics, as well as more between student variance by comparison with English.

Schooltype Differences in English and Mathematics Achievement

35. As we are interested not only in between school differences in general but in differences across the different schooltypes, a further base model was run to test schooltype differentiation in English and mathematics achievement. The results are reported in Table 7. The mean achievement(constant) is for Group A schools which served as the reference point. As could be expected, the different schooltypes are heavily 'loaded' variables, delineating tremendous resource disparities, as indicated in our descriptive analyses above. Thirty-six percent of overall variance in English achievement is explained by the inclusion of these schooltype variables and 83% of between school differences. Schooltype explains a much smaller proportion of the overall variance in mathematics achievement—only 14%—by comparison, but 56% of between school differences.

36. High-fee-paying schools are not reliably different from Group A schools in English or mathematics achievement, but the contrasts across the range of schooltypes are highly significant ($p < .0001$)[12]. The ranking of schooltypes by mean achievement is the same across the two subjects: Group A and high-fee-paying schools are at the top, followed by Group B and low-fee-paying schools, and at the bottom, district council schools. These results are unadjusted for differences in student background.

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11 Smaller between school differences in mathematics achievement have also been found in previous research, at secondary level (Riddell 1988).

12 Chi-square statistic for English: 235.92 (4df); for mathematics: 38.08 (4df).

Table 7. Schooltype Differences (Base Model) for English and Mathematics Achievement

	English		Mathematics	
Variable	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
Constant	8.23	.28	5.39	.24
Former B	-2.57	.36	-.76	.36
High-fee-paying	-.12	.42[a]	.75	.40[a]
Low-fee-paying	-2.68	.37	-.77	.26
District Council	-3.80	.30	-.99	.24
School-level variance explained	83%		56%	
Total variance explained	36%		14%	

Note: [a] Not significant (p > .05)

Testing Variables in Individual Regressions

37. Before proceeding with any further model-building, we tested each of the usable variables in our data set for its contribution toward an explanation of the variation in English and mathematics achievement. The results are reported in Tables 8-10, for student level, class level, and school level variables, respectively.

38. *Student Level Variables.* The best set of student level predictors included the same variables for both subjects: the pupil's age, whether or not s/he had repeated a grade, the family size, and the father's educational level (Table 8).

39. Both the log transformation and the natural metric of pupil's age were tried. The log transformation fit the data better for English and the natural metric marginally better for mathematics[13], but the log transformations were used for both subjects, for comparability, explaining 16% of between school differences in each subject. The negative coefficients for both variables are what one would expect to find, rather than the positive coefficient for age regressed on English in the natural metric. Where there is significant repetition at primary school, one would expect to find a high correlation between the age of the pupil and the number of school years a pupil has attended primary school. This is not the case in Zimbabwe, where there are relatively low repetition rates. Indeed the correlation between these two variables is .03. An age greater than the average Grade 7 pupil's age would normally indicate some sort of hardship in access to primary school.

40. Children who had repeated a grade (determined simply by the number of school years they'd attended primary school) had a stronger negative relationship on mathematics achievement than on English achievement, reducing the score by .5 point.

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[13] For English (t=9.7) for the log of age against (t=2.0) for the natural metric; for mathematics (t=6.5) for the log of age against (t=7.5) for the natural metric.

Table 8. Coefficients of Student-Level Variables Estimated in Individual Multi-Level Regressions on English and Mathematics Achievement
(Standard Errors)

	English					*Mathematics*				
		Percent Variance Explained					*Percent Variance Explained*			
Variable	*Coefficient*	*Sch.*	*Cl.*	*Stud.*	*Tot.*	*Coefficient*	*Sch.*	*Cl.*	*Stud.*	*Tot.*
Female (0=male)	.01 (.04)[a]	-	-	-	-	-.05 (.04)[a]	-	-	-	-
Age	.04 (.02)	3	1	-	1	-.15 (.02)	13	2	1	4
Log Age	-6.29 (.65)	16	2	8	11	4.65 (.72)	16	4	6	7
Repeater (0=Non-Repeater)	-.13 (.06)	1	-	2	1	-.49 (.06)	8	1	3	4
Non-English	-.11 (.08)[a]	-	-	-	-	.16 (.09)[a]	-	-	-	-
Family Size	-.04 (.01)	5	2	4	4	-.03 (.01)	6	-	2	2
Father's Education[b]		10	-	6	7	-	17	-	3	5
(Reference=No Education)										
Primary	.10 (.07)[a]					.11 (.07)[a]				
Junior Certificate	.21 (.06)					.12 (.07)[a]				
'O' Level	.16 (.09)[a]					.09 (.10)[a]				
'A' Level	.46 (.12)					.39 (.13)				
Mother's Education										
(Reference=No Education)										
Primary	.08 (.06)[a]					.02 (.07)[a]				
Junior Certificate	-.05 (.07)[a]					-.21 (.08)[c]				
'O' Level	-.10 (.11)[a]					-.30 (.12)[c]				
'A' Level	-.04 (.14)[a]					-.04 (.16)[a]				

Notes: [a] Not significant ($p > .05$)
[b] Chi-square ($p = .0003$) for English and ($p = .02$) for mathematics for comparisons across categories.
[c] Counterintuitive.
Measured from grand mean except where noted.

41. A pupil's family size had a small influence on both her/his English and mathematics achievement. Children from smaller families did better on both examinations.

42. Father's education had the strongest effect on achievement in both subjects, explaining 7% and 10% of the total variance in English and mathematics achievement, respectively. Although individual dummy variables were not always significant, the contrasts across the categories were significant.[14] The highest increments in achievement were estimated for children whose fathers had an 'A' level education, as could be expected.

43. Several student level variables were found to be insignificant predictors of Grade 7 examination results: gender, home language, and mother's education. Although gender was not found to be a

[14] The chi-square tests produced results of ($p = .0003$) and ($p = .02$) for English and mathematics, respectively.

significant variable, the direction of the influence of gender was different for the two subjects, being a positive relationship for girls in English, and a negative relationship in mathematics.[15] Similarly, for home language, although insignificant, the coefficient for the regression on English was negative, as would be expected, unlike that for the regression on mathematics. Seventy-five percent of the pupils in the sample reported that their mothers had no education, so the lack of significance of mother's education can best be understood by the lack of discrimination of this variable, rather than its being counter-intuitive.

44. *Class Level Variables*. The best set of class level explanatory variables consisted of the teacher's gender, the teacher's age, the teacher's qualifications, the availability of texts in the classroom, and for mathematics, additionally, the amount of instructional time devoted to mathematics (Table 9).

45. On first inspection, female teachers seem to have a strong influence on achievement in both English and mathematics, raising achievement by between .56 and .66 points. It is important to note that in this sample 82% of female teachers are in urban schools, however, urban being defined as Bulawayo and Harare, and not including those small towns which were also sampled. The strength of the regression of teacher's gender on achievement disappears when regressed together with the urban/rural variable.

46. Older teachers seem to have a positive influence on pupils' Grade 7 achievement. The log transformations of this variable only marginally improved the fit, so the natural metric was retained. Ten percent of between school differences were explained by this variable. Teachers at the low-fee-paying and district council schools were younger than the average teacher's age of 33 years. No doubt some of these differences are being captured by this variable. Not surprisingly, teacher's qualifications influenced pupil achievement in English and mathematics. Reported in Table 9 are both the regressions of the dummy variables for all the qualification bands, using 'standard trained' as the reference point, as well as the dummy variable for 'standard trained' vs. all the other categories. It is clear that teacher's qualifications have a stronger influence on mathematics achievement than on English. The differentiation of the 'untrained' qualification band from 'standard trained' is most notable for mathematics achievement.

47. The final significant class level variable uncovered in the individual regressions for both subjects was the availability of textbooks. This influence was stronger for mathematics than for English, accounting for 57% of between school variation in mathematics, 40% in English. The log transformation of this variable was tested, but did not fit better than the natural metric.[16]

48. As already pointed out, there was much variation in the number of hours of instructional time devoted to mathematics between schooltypes. Not surprisingly, therefore, this variable added a further dimension to the explanation of achievement differences, whereas it was not significant in the regression on English achievement.

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[15] While such tests of significance are relevant for average, fixed relationships across classes and schools, further investigation is merited to determine whether a gender gap exists in individual schools (entailing modelling gender as a random variable at least between schools). Preliminary investigations of gender as a random variable at the school level regressed on mathematics achievement, point to the existence of varying slopes between schools, with the gender gap smaller, the higher the achievement of boys in the school.

[16] Raudenbush and Bhumirat (1992) illustrate the use of the logs of various physical resource variables in a school effectiveness study of Thailand, enabling investigation of diminishing returns to resources. This was attempted here.

Table 9. Coefficients of Class-Level Variables Estimated in Individual Multi-Level Regressions on English and Mathematics Achievement
(Standard Errors)

	English						Mathematics					
			Percent Variance Explained						Percent Variance Explained			
Variable	*Coefficient*		*Sch.*	*Cl.*	*Stud.*	*Tot.*	*Coefficient*		*Sch.*	*Cl.*	*Stud.*	*Tot.*
Female teacher (0=Male)	.56	(.16)	12	5	-	6	.66	(.19)	16	2	-	4
Teacher's Age	.02	(.01)	10	-	-	4	.03	(.01)	22	-	-	4
Log Teachers' Age	1.52	(.73)	10	-	-	4	2.42	(.87)	23	-	-	4
<u>Teacher Qualification</u>[b] (Reference-Standard Trained)	-		8	-	-	3	-		28	-	-	7
Form 4 + 2 years	.24	(.24)[a]	-	-	-	-	.14	(.45)[a]	-	-	-	-
Form 2 + 2-3 years	-.07	(.13)	-	-	-	-	-.28	(.28)[a]	-	-	-	-
Untrained	-.41	(.14)	-	-	-	-	-1.41	(.32)	-	-	-	-
Standard Trained (0=Untrained & Non-Std. Qual.)	.40	(.17)	6	2	-	3	.59	(.21)	14	-	-	3
Teacher Experience	.014	(.008)	-	-	-	-	.019	(.01)[a]	15	-	-	3
Class Size	.03	(.019)	-	-	-	-	.026	(.016)[a]	-	-	-	-
Log Class Size	2.36	(1.2)[a]	2	3	-	1	1.94	(1.07)[a]	4	-	-	1
Planning Time	-.03	(.02)[a]	-	-	-	-	-.018	(.023)[a]	-	-	-	-
Marking Time	-.003	(.01)[a]	-	-	-	-	.003	(.02)[a]	-	-	-	-
Instruction Time	.0002	(.0008)[a]	-	-	-	-	.004	(.002)	14	-	-	3
Log Instruction Time	.44	(.78)[a]	-	-	-	-	1.80	(.55)	1	-	-	4
Class Activities	-.03	(.04)[a]	-	-	-	-	.04	(.06)[a]	-	-	-	-
Text Available	1.86	(.33)	40	-	-	16	2.21	(.32)	57	-	-	13
Log Texts	2.45	(.46)	38	-	-	15	2.92	(.44)	53	-	-	12
Supervised Study	.04	(.04)[a]	-	-	-	-	.13	(.06)	2	3	-	-
Teaching Load	-.0006	(.02)[a]	-	-	-	-	-.005	(.02)[a]	-	-	-	-
Game Time	.02	(.04)	-	-	-	-	.002	(.05)[a]	-	-	-	-

Notes: [a] Not significant ($p > .05$)
[b] Chi-square $p = .0177$ for contrasts for English; $p = .0002$ for Mathematics.
Measured from grand mean except where noted.

49. Several of the variables on which data were collected at the class level were not found to be significant in explaining variation in English and mathematics achievement. Among these were the years of teaching experience of the classroom teacher and classroom size, both often thought to be reliable predictors of student achievement. The log transformation of class size was tried in case diminishing returns characterized the regression of this variable on achievement, but neither variable fit well. The range of class sizes in Zimbabwe is relatively contained, compared to many other countries in which the ratio from the top to the bottom would be several times higher.

50. None of the variables describing the use of time by the teacher in class or in preparation for the class was significant, outside of instructional time in mathematics, as already noted. The provision of supervised study in mathematics was marginally significant, explaining very little variation in achievement.

51. *School Level Variables.* The best set of school level variables uncovered in the individual regressions on English and mathematics achievement included: the gender of the head teacher, the head's qualifications, whether the school was single-sex, also whether boarding, the average pupil-teacher ratio at the school, the percentage of African pupils, the amount of supervision of both experienced and inexperienced teachers at the school, the overall school availability of texts, whether or not there was a library, and the percentage of trained teachers at the school (Table 10).

52. Some of these variables explain much of the variance in achievement but this is due to the fact that they distinguish a small sub-sample of the schools surveyed. For instance, having a female head teacher, being a single-sex or a boarding school, and having a low percentage of African pupils are all distinguishing characteristics of a very small proportion of the schools sampled. Only 9% of the schools had a female head, nearly all at high-fee-paying schools. Ninety-five percent of the schools were coeducational, those single-sex being only at Group A and more often high-fee-paying schools. Boarding schools, similarly, were found almost exclusively among Group A and high-fee-paying schools and constituted only 8% of those sampled. Finally, Group A schools and high-fee-paying schools alone had less than 100% African enrollment, comprising 79% for Group A schools and 37% for high-fee-paying schools. Thus, unless one is specifically interested in contrasting boarding with day schools, or single-sex with coeducational schools—in which case a different sampling frame would have been devised—it is unhelpful to rely on such variables to explain the variance in achievement in modelling for school effectiveness purposes because their explanatory power swamps other variables of greater interest to and greater capacity for manipulation by education authorities.

53. Several other variables which describe the school were of interest. Pupils at schools having a 'standard trained' head teacher achieved better results in both Grade 7 subjects. The effect of the size of schools on performance is not negative, but rather positive, the log transformation fitting better than the natural metric, and explaining 8% of between school differences in both subjects.[17] The percentage of trained teachers at a school has a very positive effect on achievement in both subjects, explaining 25% and 29% of between school differences in English and mathematics achievement, respectively.

54. A most peculiar finding emerges from the regressions on English and mathematics achievement of the variables denoting the number of times experienced and inexperienced teachers are supervised.

[17] For English ($t=1.39$) for the natural metric and ($t=2.78$) for the log of school size; for mathematics, ($t=2.0$) and ($t=2.74$), respectively.

Table 10. Coefficients (Standard Errors) and Variance Explained for Combinations of Student-level and School-type Variables Regressed on English Achievement

	Coefficient (Standard Errors)					
Variable	*1E*	*2E*	*3E*	*4E*	*5E*	*6E*
Constant	5.62	6.00	4.85	5.10	5.89	5.90
	(.16)	(.21)	(.19)	(.19)	(.13)	(.12)
Log age	-5.02	-5.00	-	-5.14	-	-5.05
	(.66)	(.66)		(.67)		(.67)
Repeater	-0.46	-0.46	-	-0.47	-	-0.44
	(.06)	(.06)		(.06)		(.06)
Family size	-0.04	-0.04	-	-0.04	-	-0.04
	(.01)	(.01)		(.01)		(.01)
Father primary	0.09	0.09	-	0.10	-	0.09
	(.06)[a]	(.06)[a]		(.07)[a]		(.07)[a]
Father J. C.	0.15	0.15	-	0.16	-	0.13
	(.06)	(.06)		(.06)		(.06)
Father O	0.12	0.13	-	0.13	-	0.13
	(.09)[a]	(.09)[a]		(.09)[a]		(.09)[a]
Father A	0.39	0.39	-	0.40	-	0.37
	(.11)	(.11)		(.12)		(.12)
Former B	-	-0.22	-	-	-	-
		(.21)[a]				
High Fee Paying	-	0.20	-	-	-	-
		(.25)[a]				
Low Fee Paying	-	-0.40	-	-	-	-
		(.19)				
District Council	-	-0.77	-	-	-	-
		(.19)				
Female teacher	-	-	0.63	0.28	-	-
			(.16)	(.08)		
Age of teacher	-	-	0.03	0.03	-	-
			(.01)	(.01)		
Standard trained teacher	-	-	0.73	0.67	-	-
			(.19)	(.18)		
Texts (class)	-	-	1.42	1.15	-	-
			(.33)	(.32)		
Pupil-teacher ratio	-	-	-	-	-0.06	-0.05
					(.02)	(.02)
Texts	-	-	-	-	1.81	1.48
					(.56)	(.53)
Trained teachers	-	-	-	-	0.03	0.02
					(.005)	(.005)
Percent Variance explained (total)	17	21	24	33	32	37
School	27	35	57	66	65	70
Class	8	10	0	5	2	11
Student	10	10	0	9	7	10

Notes: [a] Average for non-repeater, father no education at grand means as noted.
[b] Measured from grand mean.

Significant, negative coefficients, stronger for the supervision of inexperienced than for experienced teachers result from these regressions. Although it doesn't stand to reason in the case of the supervision of experienced teachers, the negative coefficient for the supervision of inexperienced teachers may be touching on the fact that there are fewer trained teachers at, for example, district council schools, which, as we have already noted, report greater amounts of supervision at their schools. Intuitively, one would expect head teachers' supervision to have a positive effect; further investigation is clearly necessary to understand better what is producing not only a negative coefficient, but a negative connotation!

55. The availability of textbooks at the school level corroborates the strong positive relationship with achievement found at the class level, though here the relationship is stronger for English than for mathematics. The existence of a school library also has a positive relationship with Grade 7 achievement, stronger for English than for mathematics.

56. The percentage of trained teachers in the school is the strongest variable explaining between school differences in English and mathematics achievement, explaining 47% and 52% of these differences, respectively.

57. Variables which were not significant in explaining differences in Grade 7 achievement included the head teacher's teaching experience as well as the average number of years of teaching experience at the school, whether the head had received training as a head, the head teacher's administrative experience, whether the school practiced ability streaming (as reported by the head), whether there were double-sessions at the school, the amount and division of school instructional time into total number of hours, academic time, game time and professional time, and the average number of years teachers spend at the particular school, a measure of teacher stability.

58. The lack of relationship between achievement and the different variables denoting teaching experience seems puzzling, particularly given the significance of the teacher's age variable. However, the effect of new blood in a profession such as teaching has been noted by other researchers, and it may be that a similar phenomenon is being touched upon here.[18] The importance in the regressions on achievement of 'standard' trained teachers vs. other categories would still fit in with this theory because the new recruits, having completed their teacher training courses, would be relatively inexperienced, compared with their more experienced, 'non-standard'-trained counterparts. Further investigation of teacher variables would be necessary to weed out alternative theories, together with the more interesting interrelationship of teacher training qualification bands with teaching practices.

Progression Toward the 'Best' Model of English Achievement

59. Having run all three base analyses: (a) the variance components model; (b) the base schooltype model; and (c) the regressions of individual variables on English achievement—we put together the student level variables which could be combined in a single equation without loss of significance due to multicollinearity between the constituent variables. The resultant Model 1E is reported in column 1 of Table 10. All of the significant student level variables were able to be included. Seventeen percent of the variance in English achievement was explained by the introduction of these variables, comprising 27% of the between school variance, 8% of the between class variance and 10% of the between student variance. The significant drop in the school level variance is important to note because over one-quarter of between school differences can be seen to be accounted for by student background variables over which we have no control. This means that after the inclusion of these variables, 39% of the total variance comprises between school differences what we are seeking to explain in our further modelling and 9% of between class differences, the remainder, 52%, comprising further differences between students. We can only hope to explain the 48% of the variance which is between schools and between classes in our further modelling.

60. To what extent have these student background variables accounted for the schooltype differences illustrated in Table 7? The answer is that they have explained nearly all of them. Examination of Model

[18] See (Riddell and Nyagura, 1991) for similar findings in Zimbabwe's secondary schools.

2E (column 2 of Table 10) shows that the schooltype variable coefficients are much smaller than those reported in Table 7. Group B schools cannot be differentiated from Group A schools (our reference point) once these student background variables have been accounted for. High-fee-paying schools could not be distinguished from Group A schools in our earlier base model, nor can they here. However, once these student background variables have been regressed on English achievement, there is little left of the low-fee-paying and district council schooltype coefficients either, though they are still significant.[19]

61. Two further models were tested at this point: (a) whether the relationship between repeaters and English achievement varied from school to school; and (b) whether the best socio-economic status indicator, father's education, varied in its relationship with English achievement from school to school. Neither proved to be a fruitful tangent.

62. The next stage in model-building was to test combinations of class level variables together. Model 3E (column 3 of Table 10) reports the results of including our best set of class level explanatory variables. The correlation between teachers' qualifications and the availability of classroom texts increased the estimate of the former and reduced that of the latter, but all remained significant in combination and explained 24% of the total variation in English achievement and 57% of between school differences. Model 3E is not really legitimate, given that no adjustments have been made for student background variables. The more representative Model 4E (column 4) combines the set of class level variables in Model 3E with those student background variables used in the earlier stage of model-building. The coefficient of the variable for teacher's gender is reduced greatly in combination with the student background variable, but still retains its significance. The other variables are hardly affected in combination. Thirty-three percent of the overall variance in English achievement has been explained by this stage—16% over and above the effect of the student background variables alone. Sixty-six percent of between school differences have been explained—39% over and above the prior student level model. In addition, five percent of class level variance has been explained, and 9% of between student differences.[20]

63. At the next stage of model-building, different combinations of school level variables were regressed on English achievement. The results of the best set are reported in column 5 of Table 10, including the pupil-teacher ratio at the school, the availability of textbooks in general, and the percentage of trained teachers at the school. Model 5E illustrates that 32% of the total variance in English achievement is explained by these three variables alone, 65% of between school differences, 2% of between class differences, and 7% of between student differences. All three coefficients have been considerably reduced from their values when regressed individually on achievement, but they are still significant.

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[19] The inclusion of the schooltype variables is for purposes of comparison with our base models and not for model-building. Their explanatory power is too great for playing out the effects of any of the other variables we would like to test. (In the base schooltype model (Table 4) 83% of between school differences were explained by inclusion of these variables alone.

[20] Just as with the prior stage, the schooltype differentiation still remaining was tested by adding the schooltype variables to those variables already regressed on English achievement in Model 4E. The relative advantages of the Group B and high-fee-paying schools still seen in Model 2E are accounted for by the inclusion of the class level variables, their coefficients being significantly reduced. The disadvantages of the low-fee-paying and district council schools, however, have not entirely been accounted for.

64. Model 6E (column 6 of Table 10), builds more correctly upon Model 1E, with adjustments made for student background factors. Thirty-seven percent of the total variance has been explained, 70% between schools, 11% between classes, and 10% between students. This is an additional 20% of the total variance explained by these school level attributes over Model 1E, 43% between schools, and 3% between classes.[21]

65. In the final stage of model-building, several combinations of the three sets of 'best' variables were tested in order to get the best predictive power. Understandably, because classrooms are on the receiving end of school policies and school resources, and thus some of the variables are describing at the class level the effect of variables collected at the school level, it was not possible to combine much across these two levels due to multicollinearity. In fact, the 'best' predictive model proved to be Model 6E, relying on only the student and school level explanatory variables. The mean English achievement of a pupil who has not repeated a grade and whose father has no education, is of average age (13.7) and family size (6.6), and at a school with the average values of 36.6 pupils to each teacher, one textbook for every two pupils, and 65% trained teachers, is 5.9. For each additional pupil above the average pupil-teacher ratio, the child's English achievement is predicted to drop .05 points; if instead of having to share a textbook between two pupils, each pupil had her/his own, the child's achievement would increase by .74 points; and if instead of two-thirds of the teachers being trained, they all were trained, the child's achievement would similarly be predicted to increase .7 points. If the child were over the average age, for every increase of .1 of the logarithm of the child's age, the child's score would decrease by .5 points. If the child had repeated a grade, one would expect her/his achievement to be lower by .44 points. For every additional child in the family, the pupil's achievement would be expected to be .04 points lower. Finally, if the child's father had received an 'A'-level education, it would be expected that the child's English achievement would be .37 points higher, alternatively, with education only up to the Junior Certificate, .13 points higher.

66. If one relies solely on the final model for purposes of interpretation and policy implications, the richness of the 'story' built up to explain what accounts for achievement differences in English will be lost. It is important to utilize the information collected in the process of model building as well. The pieces of the 'story' for English achievement will be put together once we have explored the 'best' model explaining the variance in mathematics achievement, so that we can compare our findings across subjects.

Progression Toward the 'Best' Model of Mathematics Achievement

67. The same steps were taken with respect to model-building to explain variation in mathematics achievement as were taken to explain English achievement. All the student level predictors were able to be included in the regression on mathematics achievement and are reported in Model 1M (column 1) of Table 11. They include the same variables as for English: logarithm of the pupil's age, whether or not the child had repeated a grade, the size of the pupil's family, and the father's educational level. These variables combined accounted for 11% of the total variance, but 30% of what was already a smaller amount of variation between schools than was the case for English achievement, 2% of between class

[21] Adding the schooltype variables at this stage had the effect, as with the class level model, of reducing the coefficients of the Group B and high-fee-paying schools and raising those of the low-fee-paying and district council schools. Only the district council schools remained significantly different, below the other schooltypes.

Table 11. Coefficients (Standard Errors) and Variance Explained or Combinations of Student-level and School-type Variables Regressed on Mathematics Achievement

	Coefficient (St. error)					
Variable	*1M*	*2M*	*3M*	*4M*	*5M*	*6M*
Constant[a]	4.84	4.40	4.51	5.07	5.10	4.77
	(.14)	(.20)	(.20)	(.11)	(.11)	(.17)
Log age[b]	-3.63	-	-3.47	-	-3.44	-3.54
	(.74)		(.78)		(.79)	(.79)
Repeater	-.40	-	-.44	-	-.42	-.42
	(.07)		(.07)		(.07)	(.07)
Family size[b]	-.02	-	-.03	-	-.03	-.03
	(.01)		(.01)		(.01)	(.01)
Father primary	0.09	-	.07	-	.06	0.07
	(.07)[c]		(.08)[c]		(.08)[c]	(.08)[c]
Father J. C.	0.06	-	.05	-	.04	0.04
	(.07)[c]		(.07)[c]		(.07)[c]	(.07)[c]
Father O	0.05	-	.06	-	.08	0.09
	(.1)[c]		(.10)[c]		(.10)[c]	(.11)[c]
Father A	0.33	-	.29	-	.28	0.30
	(.13)		(.14)		(.14)	(.12)
Female teacher	-	.50	0.41	-	-	-
		(.19)	(.18)			
Age of teacher[b]	-	.02	0.019	-	-	-
		(.01)	(.01)[c]			
Standard trained teacher	-	.60	0.57	-	-	.39
		(.22)	(.21)			(.19)
Log Instr. Time[b]	-	1.14	1.00	-	-	1.09
		(.52)	(.49)			(.47)
Grade 7M Texts[b]	-	1.83	1.68	-	-	-
		(.36)	(.34)			
Supervised Study[b]	-	.15	.14	-	-	.13
		(.05)	(.05)			(.04)
Texts (class)[b]	-	-	-	-	-	1.88
						(.29)
Pupil-teacher ratio	-	-	-	-.054	-.04	-0.05
				(.02)	(.02)	(.01)
School Texts	-	-	-	1.33	1.13	1.48
				(.50)	(.47)	(.53)
Trained teachers	-	-	-	.02	0.02	0.02
				(.005)	(.004)	(.005)
Percent Variance explained (total)	11	21	24	19	22	27
School	30	76	80	76	81	93
Class	2	3	11	-	-	-
Student	4	1	3	2	3	3

Notes: [a] Constant Average for non-repeater, father no education, at grand means as noted
[b] Measured from grand mean
[c] Non-significant (p > .50)

differences and only 4% of between student differences. Model 1M, like Model 1E for English, gives us a new base model, for the adjustments made for student background factors renders the 'real' between school differences which we set out to explain. They comprise a mere 20% of the total variance in achievement after adjusting for student background factors, half the size of the share for English. On the other hand, between class and remaining between student differences comprise a considerably larger share than for English 1, 16% and 64%, against 9% and 53%, respectively.

68. To what extent do student background factors account for schooltype differences? First of all between school differences have been accounted for entirely by the introduction of the student background and schooltype variables. The school level variance at this stage, .175 (.1), is no longer formally significant. The model resulting from adding the schooltype variables to the student background factors is not really valid. Schooltype differences are accentuated, rather than diminished, as would be expected.[22]

69. Model 2M (column 2 of Table 11) reports the results of combining the best set of class level variables regressed on mathematics achievement. Included are the gender and age of the teacher, whether the teacher received what is now standard teacher training, the amount of instructional time devoted to mathematics, the availability of mathematic textbooks in the classroom, and the amount of supervised study time afforded by the teacher. These variables account for 21% of the total variance, comprising 76% percent of between school differences, 3% between class, and 1% between students. Model 3M (column 3) which builds upon the more valid Model 1M, adjusting for student background variables, illustrates that the addition of these class level variables accounts for an additional 13% of the total variance, comprising an additional 50% of the between school variance and an additional 9% of the between class variance in achievement. As with Model 1M the addition of the schooltype variables at this stage was not possible without counterintuitive results.

70. Model 4M (column 4 of Table 11) presents the results of the best possible combination of school level variables, according to the same criteria used in the modelling of English achievement: an attempt was made to use those variables of the greatest policy importance, rather than those descriptive variables, such as boarding or single-sex, over which little, relative control can be yielded and whose weight swamps other variables. The regression on mathematics achievement of the three variables, the overall pupil-teacher ratio at the school, the availability of school textbooks, and the percentage of trained teachers at the school accounted for 19% of the total variance in mathematics achievement, 76% of between school differences, and 2% of between student differences. Compared to Model 1M, Model 5M (column 5) which also regresses the student background variables at the same time as the school level variables, on mathematics achievement, represents an additional 11% of the total variance explained, an additional 51% between schools.

71. Different combinations of variables at all three levels were regressed on mathematics achievement in an attempt to arrive at the most powerful equation. Model 6M (column 6 of Table 11) reports our 'best' equation, accounting for 27% of the overall variance in achievement, 93% of variation between

[22] Whereas the span of the schooltype dummy variables had been between .3 and .45 standard deviation units before including pupil's characteristics, after adjustment the spread was from .02 to 1.13 standard deviation units. The coefficients of the schooltype dummy variables in the model tested at this stage were: B -1.77 (.32); HFP -.04(.39); LFP -1.51 (.33); DC -2.46 (.29).

schools and 3% between students. No significant between school variation remains[23], but the between class variation is untouched by the variables in combination. This implies, as we saw at an earlier stage, that after accounting for student background differences, much of the variation in mathematics achievement is not between schools, but rather between individual classes. This gives much more room for improvement to the class teacher than was the case found for English achievement.

72. In this 'final' model, the average mathematics achievement, the constant, is for a pupil of average age (13.7 years) who has not repeated a grade and whose father has no education. An increase of .1 points in the log of the student's age would predict a lowering of achievement of just over a third of a point; if the child had repeated a grade, we would expect her/his achievement to be lower by .42 points; for children coming from families one child larger than the average family size of 6.6 children, we would expect a marginal lowering of .03 in their mathematics achievement. Were the child of a father having an 'A' level education, we would expect the child's achievement to be raised by just under a third of a point. For every 1 point increase in the log of instruction time afforded mathematics above the average time of 103 hours, we would expect a similar increment in mathematics achievement of 1.11 points. We predict a tremendous boost in achievement for improvements in the accessibility of textbooks: if instead of having to share two textbooks in class approximately between three pupils, the ratio were raised to about three books for every four pupils, we would predict an increase in the child's achievement in mathematics of nearly two points (1.88)! For each additional hour of supervised study time above the average of 2.6 hours per week, the pupil's mathematics achievement is predicted to rise by .13 points. Finally, for each additional pupil increasing the average pupil-teacher ratio of 36.6, a decrease in the pupil's achievement of .05 points is predicted.

Analysis of Residuals

73. Having arrived at our 'best' models for explaining English and mathematics achievement, the final stage in the analysis is to analyze the residuals in order to detect 'outliers', cases worthy of further examination. The use of residuals in multilevel regression as a proxy for school effects cannot be a finely honed technique. Because the confidence intervals are generally quite wide and therefore the rankings of schools will overlap, it is not valid to do more than a broad brush slice off the top and the bottom of the residuals in order to detect 'most effective' and 'least effective' schools.

74. Table 12 reports those schools whose school level residuals were at least two standard deviations above or below the mean predicted English achievement. Among the bottom ranked schools are four district council schools, two low-fee-paying schools and one Group B school. Among the top ranked schools are five Group A schools, one low-fee-paying school and a four district council schools. An attempt was made to determine what characterizes these schools beyond those variables controlled for in the final Model 6E from which these residuals are obtained. There seems to be nothing exceptional from the information at hand, except the curious finding that the time afforded to games at the school is higher than average, and the time afforded to professional activities lower! Given the limited variables on which data were collected, and the fact that nothing is reported about the overall ethos of the school, nor indeed, the classroom teaching practices fostered, further investigation at the particular schools in question is really what is required in order to ascertain what the group of 'effective' schools has in common that would have policy implications for those schools further down on the ranking.

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[23] The between school variance for this model is .101 (.09).

Table 12. Bottom and Top Schools Ranked by Standardized School Level Residuals for English

Bottom Schools				*Top Schools*			
School ID	*School Type*	*Standardized School Residual*	*Predicted Grade*	*School ID*	*School Type*	*Standardized School Residual*	*Predicted Grade*
40	DC	-6.2422	6.2724	4	A	1.9976	7.5927
29	LFP	-5.4243	7.6628	5	A	2.3887	6.4918
15	B	-3.6575	6.9141	27	LFP	2.4626	6.3657
39	DC	-2.8016	5.5931	52	DC	2.4969	4.1351
32	LFP	-2.4995	6.0306	42	DC	2.6182	4.8013
65	DC	-2.4960	5.1178	38	DC	2.8265	5.1077
58	DC	-2.3589	5.4987	3	A	3.0390	6.3657
				43	DC	3.5164	4.3933
				7	A	3.5790	6.8057
				9	A	3.5950	6.1874

75. For mathematics, once the variables in Model 6M have been regressed on mathematics achievement, the school level variance is no longer significant. However, as we saw in the earlier analyses, class level differences were greater than school level differences, and, indeed, despite the number of class level variables entered in the final equation, we have not got a handle on those further factors accounting for between class differentiation. Table 13 reports the class level residuals obtained from Model 6M. Again, there is nothing exceptional in the variables we have describing this set of 'most effective' and 'least effective' schools. The bottom ranked classes come from eight Group B schools, four low-fee-paying schools and eleven district council schools. The top-ranking classes come from six Group A schools, six Group B schools, five high-fee-paying schools, three low-fee-paying schools and eight district council schools.

76. No high-fee-paying or Group A schools are among the bottom-ranked in either subject. The majority of schools having classes at the bottom ranks in mathematics, are also on the bottom of the English achievement ranking as well.

77. Further investigations at the particular schools and classrooms are required to go any further in understanding the basis of the distinction of the set of 'most effective' schools at the top of the ranking.

Table 13. Bottom and Top Schools Ranked by Standardized Class Level Residuals for Mathematics

Bottom Classes				*Top Classes*			
School ID	*School Type*	*Standardized School Residual*	*Predicted Grade*	*School ID*	*School Type*	*Standardized School Residual*	*Predicted Grade*
10.4	B	-5.7973	7.0685	4.1	A	2.0310	6.5901
10.3	B	-5.4183	6.7904	66.1	DC	2.0479	5.7459
67.1	DC	-4.6370	5.8178	11.3	B	2.0738	6.8185
40.1	DC	-3.7392	6.5901	26.1	HFP	2.1157	6.7946
72.1	DC	-3.6692	5.9388	23.1	HFP	2.1664	6.5013
27.3	LFP	-3.2153	6.5796	25.1	HFP	2.1816	6.4570
29.4	LFP	-3.0695	6.1854	23.2	HFP	2.1928	6.7946
80.1	DC	-2.9900	5.9519	57.2	DC	2.2201	6.9277
15.2	B	-2.8587	6.8998	3.1	A	2.4819	5.9891
68.1	DC	-2.6275	6.1327	36.4	LFP	2.5897	5.4936
55.2	DC	-2.5516	6.2604	19.5	B	2.6113	6.6152
74.2	DC	-2.4797	6.5652	53.1	DC	2.6269	6.4730
19.1	B	-2.4391	6.3517	22.1	HFP	2.6679	6.6434
29.2	LFP	-2.4325	6.37[illegible]1	18.3	[illegible]	2.7200	6.7204
39.2	DC	-2.2454	6.1904	2.1	A	2.7908	6.1723
31.1	LFP	-2.1992	7.1530	14.1	B	2.8623	6.5652
83.2	DC	-2.1418	6.7765	27.1	LFP	2.8946	6.5901
[illegible].4	B	-2.1321	6.4952	9.1	A	2.8949	6.5551
48.2	DC	-2.1209	6.4807	63.1	DC	3.2841	6.0377
11.4	B	-2.1075	7.0299	48.1	DC	3.6110	6.5465
64.1	DC	-2.0986	6.8047	43.2	DC	3.6232	6.1890
13.1	B	-2.0519	5.9891	53.3	DC	3.6952	6.4448
15.4	B	-2.0027	7.1530	7.1	A	3.7206	6.3028
				12.4	B	3.7501	6.7485
				52.1	DC	4.3216	6.6525
				8.1	A	4.7144	6.2762
				29.7	LFP	6.0517	5.7615
				10.1	B	6.4707	6.4037

IV. Conclusions

78. We are now at the stage where it is possible to answer some of the questions raised in this research. We have found that schooltype differences in English achievement go considerably beyond differences in student intake, whereas for mathematics achievement, once one has controlled for student background variables, schooltype is not a significant discriminating factor. We can account for schooltype differences in English, however, with either class or school level variables. We have found that for mathematics achievement, focussing at the class level is likely to be more productive in influencing achievement, whereas the broader school level focus for English achievement may be more appropriate. We are able to account entirely for between school differences in mathematics on the basis of the variables included in our model. Differences between schools in English achievement, however, remain, after our best attempts at modelling with the variables at hand.

79. What are the handles at our disposal for influencing achievement in either of these two subjects? Not surprisingly, textbooks and trained teachers come up as highly significant variables across both subjects, at both the class and school levels.[24] Both trained teachers and the availability of textbooks for mathematics instruction are more important than for English, however, in equalizing disparities across schools, as can be seen first in the individual regressions on achievement and subsequently in the further modelling carried out. More of the variance in mathematics achievement between schools is explained by these variables. In addition, older teachers seem to achieve better results with their charges than new recruits across both subjects. Also, teacher's gender seemed to be a promising variable at first, the pupils of female teachers outperforming those of male teachers. However, once we understood that the variable was describing in fact the urbanicity of the school, further concentration on this variable proved futile, particularly outside the introduction of additional classroom practice variables (not available in this study).

80. Two additional class level variables proved of importance in explaining achievement differences in mathematics, but not in English. The amount of instructional time devoted to mathematics and the number of hours of supervised study given by the teacher were significant. Clearly these are both areas meriting attention by the responsible authorities of the different schooltypes. In particular, supervised study, which has also proved to be a successful non-formal type of education in Zimbabwe through 'study groups'[25], may hold out an inexpensive, supplementary means of raising students' mathematics performance.

81. At the school level, the three variables, the pupil-teacher ratio, the availability of textbooks, and the percentage of trained teachers, proved highly significant across both subjects, explaining more between school differences in mathematics, but accounting for more of the total variance in English.

82. What is of interest in examining the interaction of these different variables with the schooltype variables is the intractable <u>disadvantage</u> of the low-fee-paying and district council schools, the poor

[24] The average academic qualifications of the teachers at the schools surveyed in a 1992 survey of Zimbabwe's primary schools was the most important factor distinguishing its group of 'most effective' schools, also. In addition to the physical resources which also distinguished this group, the pupil-teacher ratio and those schools with more full-time female teachers as well as those with more teaching experience who lived on their own were the notable factors. (Ross and Postlethwaite 1992)

[25] Study groups consist of groups of students brought together in registered study centers with a mentor, provided at government expense.

cousins to the other schooltypes. Although we can go quite far in explaining the differentiation across schools and schooltypes with the inclusion of the variables on which data were gathered in this study, it is notable that after accounting for student background influences on the 'effectiveness' of different schooltypes, as well as the manifold class and school level variables, there is still something which is missing in these two schooltypes, relative to the others. We would allege that the newness of these schooltypes, together with their disadvantageous physical resourcing afforded either by the government or their relatively much poorer supporting communities, requires attention by central government re: the equalization of no longer just access, but rather, of access to quality education. Further investigations at some of the outliers detected in the residuals analysis should be of some help in determining further characteristics at the school and classroom level which can ameliorate disparities in primary school achievement in English and mathematics in the face of physical resource disparities.

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Annex A: Glossary of Variable Names

Student-level Dependent Variables

GR7E:	Grade 7 English examination score measured in November 1990; possible score: 1-9.
GR7M:	Grade 7 mathematics examination score measured in November 1990; possible score: 1-9.

Student-level Explanatory Variables

SEX:	A dummy variable (1=female; 0=male)
AGE:	Age in years as of November 1990
PRESCHYR:	Years spent in preschool
SCHLYRS:	Total years taken to reach Grade 7
DAYSABS:	Number of days a pupil was absent from school in terms 1 and 2 in 1990
EHWTIME:	Hours per week devoted to English homework
MHWTIME:	Hours per week devoted to mathematics homework
HOMLAN:	A dummy variable (1=Non-English; 0=English)
FAMSIZE:	Number of children in the family
FEDUC:	Father's education level (1=Did not go to school; 2=Primary Education up to Grade 7; 3=Form 2/Grade 9 (Junior Certificate); 4=Form 4 (O-level), 5=Form 6 (A-level); 6=University degree(s).
MEDUC:	Mother's education level (1=Did not go to school; 2=Primary Education up to Grade 7; 3=Form 2/Grade 9 (Junior Certificate); 4=Form 4 (O-level), 5=Form 6 (A-level): 6=University degree(s).

Class-level Explanatory Variables

TCHSEX:	A dummy variable (1=Female; 0=Male)
TCHAGE:	Teacher's age in years as of 1990
TCHQUAL:	A dummy variable (1=trained, i.e. Form 4 plus 2 to 4 years training & Form 2/Standard 6 plus 2 to 3 years training; 0=untrained)
CTCHEXP:	Years Grade 7 teacher has taught

CLSIZE: Number of students in the class

EPLAN: Teacher's English planning hours per week

MPLAN: Teacher's mathematics planning hours per week

EMARK: Hours per week spent grading/marking English pupils' work

MMARK: Hours per week spent grading/marking mathematics pupils' work

EINSTR: Total English hours of instruction before Grade 7 examination

MINSTR: Total mathematics hours of instruction before Grade 7 examination

TCHABS: Days teacher was absent from school in terms 1 and 2 of 1990

ECLACT: Hours per week spent on pupil classroom activities in English

MCLACT: Hours per week spent on pupil classroom activities in mathematics

GR7ETEXT: English textbook availability in Grade 7, i.e. ratio of pupils per English textbook. 1=one textbook per pupil; 0.5=one textbook per two pupils; 0.33=one textbook per three pupils; 0.25=one textbook per four or more pupils

GR7MTEXT: Mathematics textbook availability in Grade 7. See GR7ETEXT for meaning.

ESUPSTDY: Supervised English study hours per week

EUNSUP: Unsupervised English study hours per week

MSUPSTDY: Supervised mathematics study hours per week

MUNSUP: Unsupervised mathematics study hours per week

TCHLOAD: Teacher's total teaching hours per week

TCHGAME: Hours per week spent by the teacher on games and sports

School-level Explanatory Variables

HMSEX: A dummy variable (1=Female; 0=Male)

HMQUAL: A dummy variable (1=Qualified headmaster; 0=Under-qualified headmaster)

HMTCHEXP: Headmaster's teaching experience in years

HMTRD: A dummy variable (1=trained as HM; 0=untrained as HM)

HMADMIN:	Headmaster's administrative experience in years
SCHLSEX:	A dummy variable (1=single sex school; 0=co-education school)
BOARD:	A dummy variable (1=Partly boarding; 0=not boarding)
STREAM:	A dummy variable (1=streaming; 0=No streaming)
SESSION:	A dummy variable (1=one session; 0=two or more sessions)
SIZE:	Number of pupils enrolled in the school
TPR:	School average number of pupils per teacher
PERCAF:	Percentage total enrolment African
SCHLTIME:	Total school working hours in terms 1 and 2 of 1990
ACADETIME:	Total hours spent on academic activities in terms 1 and 2 of 1990
GAMETIME:	Total hours spent on games and sports in terms 1 and 2 of 1990
PROFTIME:	Total hours spent on school based inservice activities in terms 1 and 2 of 1990
SUPVEXP:	Number of times per term experienced teachers were supervised by the headmaster
SUPVINEX:	Number of times per term inexperienced teachers (2 years) were supervised by the headmaster
ETEXT:	English textbook availability for all grades in the school. See GR7ETEXT for meaning
MTEXT:	Mathematics textbook availability for all grades in the school. See GR7ETEXT for meaning
LIBRARY:	A dummy variable (1=school has a library; 0=No library)
LIBBOOKS:	Total number of books in the school library
TRDTCH:	Percentage of trained teachers in the school
TCHEXPER:	Average number of years teachers have taught based on first appointment to teaching
TCHTHIS:	Average number of years teachers have taught in present school

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